

ADMINISTRATIVE INFORMATION

1. **Project Name:** Broadly Tunable Mid-IR Hydrocarbon Sensor
2. **Lead Organization:** Physical Sciences Inc.
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3. **Principal Investigator:** Douglas J. Bamford: Phone: (925) 743-1110, fax (925) 743-1117
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4. **Project Partners:** None (this is an SBIR program)
5. **Date Project Initiated:** Date Project Initiated: 7/22/02 (Phase I); 6/27/03 (Phase II)
6. **Expected Completion Date:** 6/26/05

PROJECT RATIONALE AND STRATEGY7. **Project Objective:**

The objective of this project is to develop a new type of gas analyzer, based on laser absorption in the mid-infrared region of the spectrum, which can be used to make rapid, on-site measurements of gas-phase species of importance to energy-intensive industries.

8. **Technical Barrier(s) Being Addressed:**

The most commonly used analytic technique, gas chromatography, does not allow petrochemical manufacturing processes to be controlled in real time because gas samples must be delivered to a remote location. Real-time process control will allow the end-products of these processes to be produced more efficiently.

9. **Project Pathway:**

Our innovation is a mid-infrared laser source which meets both the performance requirements (linewidth, power, tuning range) and the practical requirements (ruggedness, compactness, ease of use, room-temperature operation, cost) of a laser source for industrial process control. In the past we have produced laser sources that meet all of the performance requirements except the requirement for a broad tuning range, which will be developed in the proposed effort. During Phase I we proved feasibility by altering the design of the laser source in manner that greatly increased the tuning range without altering any of the other performance parameters. Speciation of a hydrocarbon mixture important in petrochemical manufacturing was demonstrated. In Phase II we will prove practicality by producing a compact prototype analyzer tailored for operation in a wavelength range of interest to analytical chemists in the petrochemical industry, and demonstrating its usefulness in a working petrochemical facility.

10. Critical Technical Metrics:

Baseline Metrics

- gas analyzers based on gas chromatography have response times measured in tens of minutes
- gas analyzers based on laser spectroscopy, capable of rapidly detecting multiple species with the accuracy and ruggedness needed for on-site measurements, do not exist today

Project Metrics

- production of gas analyzer capable of measuring at least three species of importance in the control of a petrochemical process, with sufficient accuracy to enable the process to be controlled, and with a response time of a few seconds;
- demonstration that this gas analyzer is rugged enough to make the required measurements when deployed in an industrial facility.

PROJECT PLANS AND PROGRESS**11. Past Accomplishments:**

- key component of mid-infrared laser source designed, fabricated, and tested;
- tuning range of 250 reciprocal centimeters demonstrated using the key component;
- absorption spectra of pure hydrocarbons, and mixtures of them, obtained using the laser source; ability to quantitatively measure the composition of a mixture demonstrated;
- conceptual design for a portable prototype instrument created;
- engineering data needed to increase the output power and wallplug efficiency of the laser source obtained;
- laser source with improved output power and wallplug efficiency designed, fabrication of this source initiated.

12. Future Plans:

- fabrication of the improved laser source will be completed;
- the improved laser source will be tested;
- the design/fabrication/test cycle will be iterated to produce an improved laser source;
- a portable prototype gas analyzer based on the improved laser source will be designed, and fabricated;
- the performance of the gas analyzer will be measured by using it to measure the composition of calibrated gas mixtures in the laboratory;
- the portable gas analyzer will then be used to measure species concentrations in a working petrochemical facility.

13. Project Changes:

No changes in scope, approach, or schedule are foreseen at this time.

14. Commercialization Potential, Plans, and Activities:

This information is proprietary.

15. Patents, Publications, Presentations:**5 Presentations**

“Portable Mid-Infrared Sources for the Measurement of Methane and Carbon Dioxide”, presented at Optical Society Annual Meeting, Orlando, FL, October 2002.

“Generation of Broadly-Tunable Mid-Infrared Radiation in Periodically-Poled Lithium Niobate Waveguides”, presented at Conference on Lasers and Electro-Optics, Baltimore, MD, June 2003.

“Broadly Tunable Mid-Infrared Hydrocarbon Sensor”, presented at Department of Energy Sensors and Automation FY03 Annual Review Meeting, San Francisco, CA, June 2003.

“Broadly Tunable Mid-Infrared Laser Source for Industrial Process Control”, presented at International Forum on Process Analytical Chemistry”, Arlington, VA, January 2004.

“Monitoring of Small Organic Molecules Using a Broadly-Tunable Mid-Infrared Laser Source”, present at Conference on Lasers and Electro-Optics, San Francisco, CA, May 2004.